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PATENTS ACT 1977

IN THE MATTER OF a European
Patent (UK) in the name of
Mauser-Werke Oberndorf Maschinenbau GmbH

I, AMANDA JANE CONRAD, of Sigma House, 6-8 Garden Street, Tunbridge Wells, Kent, declare that I am conversant with the German and English languages and that to the best of my knowledge and belief the accompanying document is a true translation of the authentic text of European Patent No. 1 035 936 (formerly Application No. 99 955 676.4).

AJ Conrad

Signed this 5th day of February 2003

The invention relates to a method of effecting fracture separation of workpieces according to the preamble of claim 1 and to a machining unit, in particular for effecting said method, according to the preamble of claim 4.

Fracture separation is used for the formation of divisible bearing points, e.g. of connecting rods or crankcases. During connecting rod manufacture, first a connecting rod blank comprising a piston-side connecting-rod eye, a connecting rod and a crankshaft-side bearing portion (large bearing eye) is produced. There are then formed in the inner peripheral surface of the bearing portion two diametrically disposed notches, which define a fracture plane, along which fracture separation of the connecting rod is effected so that the bearing portion is divided into a bearing cap and a bearing base. In said case, both the cap and the connecting rod may be severed.

The fracture separation operation results in micro- and macro toothing, which allows the bearing cap to be joined in a precisely fitting manner to the bearing base after micro-machining of the so-called big eye of the bearing portion.

Until now, substantially two procedures have been used to introduce the notches. In the classic method the notches are formed by a broaching operation, wherein the notches - owing to the shape of the broach - have relatively large notch widths.

In recent years the broaching method has been superseded by so-called "laser notching" which is described e.g. in DE 19534360A1, which discloses the closest prior art, and in

US 5,208,979A. With said method the notches are introduced by laser beam, thereby considerably simplifying formation of the notches compared to the conventional solution because practically no tool wear and no cooling/lubricating medium has to be taken into consideration.

After introduction of the notches, fracture separation and the blowing-out of fragments, the connecting-rod parts are screwed together in a screwing station, wherein the screwing operation is controlled in such a way that during final assembly of the connecting rod the setting in the parting plane region lies below a limit value.

The screwing operation starts with controlled insertion of the screws, wherein the screwing depth is checked and binding and/or the presence/absence of a thread is detected.

As soon as the screws abut, the assembly operation is effected, wherein pre-centring is effected by screw clearance constricted by the flat support of the end faces or guidance by a guide part in the big eye to locate the correct assembly position.

This is followed by angle- and moment-controlled assembly and then by connecting-rod- and/or screw-specific, torque-, angle- or yield-point-controlled tightening.

In other words, during the screwing operation the tightening torque of the screws has to be selected in such a way that at the start of the screw connection an assembly is effected, in which the micro toothing and the macro toothing are brought into the correct position relative to one another, then by

increasing the tightening torque the stress in the fracture plane is increased in such a way that it is located in the region of the yield point of the material so that a setting occurs. The screw connection is then loosened, any generated fragments are blown out and the screw connection is re-established with a torque specified by the manufacturer.

In conventional cracking units, the connecting rod, after fracture separation, is conveyed to a blowing station and from there to a screwing station, in both of which the specified machining steps are carried out in succession.

The drawback of said known solution is that the construction of individual stations entails a considerable hardware outlay because the stations have to be connected to one another by suitable conveying units. In said case it is particularly difficult during conveying to maintain the position of the connecting-rod parts relative to one another so that the assembly/setting step may be carried out as easily as possible.

Against said background, the underlying object of the invention is to provide a method and a machining unit, with which the fracture separation and assembly of the workpiece parts may be carried out with a minimal hardware outlay.

Said object is achieved, in terms of the method, by the features of claim 1 and, in terms of the machining unit, by the features of the coordinated claim 4.

According to the invention the fracture separation, blow-out and screw-connection (assembly, setting) steps are effected in

a single station, in which the connecting rod is firmly fixed in a reference position. Said measure eliminates conveying between the individual stations, thereby enabling the assembly/setting operation to be effected with a considerably improved positioning accuracy because damage of the fracture surfaces is reduced compared to conventional solutions.

The hardware outlay may be further reduced when the expanding arbor is used to fix the position during the blowing-out and screw-connection operation.

A particularly high assembly quality with reduced cycle times is achieved when the blowing operation is effected as early as during fracture separation so that the fragments are immediately blown out of the parting plane region.

Should the expanding arbor be used to fix the position, it is particularly advantageous when it is activated in such a way that during the screw-connection operation it applies a specific counterforce onto the workpiece so that the bearing parts (bearing base, bearing cap) are guided by the expanding arbor during the screw-connection operation. This means that, in said variant, the effective diameter of the expanding arbor may be radially increased and decreased in a controlled manner.

The nozzle or the nozzles of the blow-out device may in said case open out in an expanding jaw of the expanding arbor or in the expanding wedge, which is driven in axially to move the expanding jaws apart.

A particularly advantageous effect is achieved when the nozzles of the blowing device for blowing out the fragments open out in the expanding wedge so that the engagement and/or return motion of the expanding wedge may be utilised to blow the fracture plane clear over as large a region as possible with a moving nozzle.

Adaptation to different component geometries is particularly simplified when the centre plane of the bearing portion to be cracked is always brought into a position relative to a fixed reference plane of the cracking station, which is defined by the effective plane of the screwing unit and blowing device and the effective centre of the expanding arbor. It is thereby guaranteed that the centre of the workpiece is disposed always in the height region of the expanding arbor where the optimum expanding effect is achievable. Furthermore, given such a definition of the zero point position, a height adjustment of the screwing unit and the blowing device is not necessary, with the result that setting-up times may be kept to a minimum.

Alternatively, the screwing unit and e.g. a counter-holding device may be conveyed jointly along a vertical axis, so that by moving the screwing unit an adaptation to different workpiece heights is possible.

As the fracture surface is divided by the eye of the bearing portion into two sub-regions, the fracture does not occur simultaneously over the entire fracture surface, rather the two sub-regions are fractured in succession. In unfavourable circumstances it may happen that, after fracture separation of the first sub-region, the remaining sub-region does not

fracture straightaway but is first subjected to a deformation, which practically rules out subsequent assembly to the required accuracy.

To avoid such an excessive deformation of the second sub-region, in an advantageous embodiment of the invention the two sub-regions are supported in such a way that a fracture is achievable in both sub-regions. Said support may take the form of a so-called "support balance" but also the form of a "support bridge".

The machining unit is usable in a particularly versatile manner when it is also provided with a laser unit for introducing the notches. In said embodiment a conveying unit is provided, by means of which the connecting rod, after introduction of the notch, is conveyable to the region where the cracking, blowing-out and screw-connection operation occurs.

By providing at least two support balances and a slider, which is used to apply force to the support balances, either large bearing caps or a plurality of bearing caps may be uniformly cracked off.

When pins of the support balance extend orthogonally to the slider, an advantageous transfer of force may be achieved with a low hardware outlay.

With regard to the hardware outlay, it is particularly advantageous when the transfer of force between support balance and slider is effected via oblique faces of the slider, with which the support balance may be in contact. Put

more precisely, a good transfer of force is achievable with minimal mechanical parts.

The support balance preferably comprises two pins, which are connected by a yoke. Thus, forces of equal magnitude may be applied onto two sides of a bearing cap.

Further advantageous developments of the invention are the subject matter of the further sub-claims.

There now follows a detailed description of preferred embodiments of the invention with reference to diagrammatic drawings, in which:

Fig. 1 shows a diagrammatic side view of a machining unit according to the invention in a compact style of construction;

Fig. 2 shows a detailed view of a cracking station of the machining unit of Fig. 1;

Fig. 3 shows a cross-section through an expanding arbor of the cracking station of Fig. 2;

Fig. 4 shows an embodiment, in which a bearing cap is supported by means of a support balance;

Fig. 5 shows a further embodiment of a support of a bearing cap;

Fig. 6 shows a further embodiment of a machining unit;

Fig. 7 shows a setting-up device for the machining unit

Figs. 8 and 9 show a sectional view and a plan view respectively of an embodiment, in which a plurality of bearing caps are supported by means of seven support balances.

Fig. 1 shows a side view of part of a compact machining unit 1, by means of which workpieces, e.g. connecting rods 2, are to be cracked. The machining unit 1 has a conveying unit 4 with cassettes 6, on which the connecting rods 2 are fastened. By means of the conveying unit 4, which is designed as a rotary table, the connecting rods 2 may be conveyed from a loading station which is merely indicated in the drawing to a laser unit 10, which is indicated in Fig. 1 by dash-dot lines. The laser unit 10 has two lens systems, which are arranged offset by 90° relative to one another, so that two diametrically disposed notches may be introduced simultaneously or consecutively into the large eye of the connecting rod 2. Such a laser unit 10 is described e.g. in the previously mentioned DE 19534360 A1 of the applicant. For further details of the laser unit, for the sake of simplicity, reference is made to said prior publication.

The machining unit 1 according to the invention further has a cracking station 12, in which by means of an expanding arbor 14 the bearing portion having the large eye of the connecting rod 2 is separated by fracture into a bearing shell and a bearing base. For fixing the position of the connecting rod 2 on the cassette 6 in the horizontal direction, a counter-holding device 16 is formed on the machining unit 1 and is extendable by means of a hydraulic or pneumatic cylinder 18 in the vertical direction (view according to Fig. 1), so that a guide pin 20 engages into a guide recess 21 of the cracking unit 12 and a horizontal stop 22 having two contact portions

extending at right angles to the drawing plane in Fig. 1 is brought into contact with the outer periphery of the bearing portion of the connecting rod 2.

After the fracture separation operation has been effected, the bearing cap is screw-connected by two clamping screws to the bearing base (connecting rod, connecting-rod small eye). For said purpose a screwing unit 24 is used, which is provided with a clamping screw magazine and a torque- or angle-controlled screwdriver.

Such a screwing unit 24 is already used in the initially described conventional solutions but the essential difference is however that, in the conventional systems, the cracked connecting rod 2 is conveyed by the conveying unit to the screwing unit 24 while, in the illustrated embodiment, the screwing unit 24 comes into working engagement with the connecting rod 2 in the same machining position as the latter occupied for cracking. This means that the position of the connecting rod 2 is not varied for the cracking and the screw-connection operations. In order to achieve this, the screwing unit 24 is conveyed on a horizontal guide 26 so that the screwing heads 28 are displaceable relative to the connecting rod 2 disposed in the cracking unit 12.

The entire cracking unit 12 is guided on a vertical guide 28 of a column of the machining unit 1 and may be displaced by means of an actuating cylinder 30 in the vertical direction so that the expanding arbor 14 may engage into its cracking position in the large eye of the connecting rod 2.

It is not intended at this point to go into detail about the machine controller and the other peripheral equipment because the concrete construction of said devices is of secondary importance for an understanding of the invention.

Fig. 2 shows an enlarged view of the cracking unit 12 of Fig. 1. According to said view, the expanding arbor 14 has a stationary expanding jaw 32 and a movable expanding jaw 34 guided so as to be movable in the radial direction relative thereto. Situated between the expanding jaws 32, 34 is an expanding wedge 36, which is movable by means of an expanding cylinder 38 in the vertical direction (view according to Fig. 2) so that, by virtue of a wedge surface 40 running up onto a correspondingly shaped opposite surface of the movable arbor half 34, the latter is movable to the right in the view according to Fig. 2 in order to initiate the cracking operation. The travel of the expanding wedge 36 is detected by a displacement sensor 42 (e.g. switch).

As is evident from Fig. 2, the expanding arbor 14 in its cracking position penetrates the large eye 48 of the connecting rod 2, which is supported on the non-illustrated cassette 6 of the conveying unit 4. Positioning of the small eye 50 plus the rod 52 is also effected by means of a fixing pin 54, which is mounted on the cracking unit 12 so as to be displaceable in the horizontal direction (view according to Fig. 2). The fixing pin 54 is preloaded into its illustrated normal position by means of a compression spring 56. The spring-loaded, horizontally displaceable position of the fixing pin 54 allows the rod 52 with the small bearing eye 50 to yield laterally during fracture separation, thereby

enabling compensation of the radial enlargement of the expanding arbor 14 after fracture has been effected.

Thus far, the cracking unit 12 is only marginally different from the conventional cracking stations so that there is no need to go into further detail.

An essential difference from the conventional solutions is that in the expanding arbor 14 blowing nozzles are formed, which enable the fragments to be blown out after the cracking operation.

There are several possible ways of designing the nozzle arrangement.

One possibility is to accommodate in the vertically movable expanding wedge 36 a suitable nozzle system, via which compressed air may be blown into the gap between the two arbor halves 32, 34. Alternatively or in addition thereto, the nozzle system may also be formed in one of the expanding jaws 32, 34, wherein it is preferred when at least some nozzles are formed in a movable part of the expanding arbor 14 (expanding wedge 36, stationary expanding jaw 32) so that the nozzles, owing to the vertical and/or radial displacement of the expanding arbor 14, alter their position relative to the fracture surface, thereby making it easier to detach and blow out fragments.

Fig. 3 shows a diagrammatic section through an expanding arbor 14 comprising the two expanding jaws 34, 32, wherein in one of the expanding jaws (e.g. the stationary expanding jaw 32) compressed-air bores 60, 62 are formed, branching off from

which are nozzle bores 64, 66, which open out in the gap 68 between the two arbor halves 32, 34.

As an alternative or in addition thereto, a compressed-air bore 70, from which nozzle bores 72, 74 branch off, is formed in the expanding wedge 36. The advantage of said variant is that the nozzle bores are aligned in the radial direction relative to the gap 68 and moved vertically, thereby assisting the blowing-out of the fragments.

Said blowing-out is assisted in the previously described solution by the fact that the nozzle bores 64, 66 are inclined towards the connecting rod 2. The nozzles may of course be introduced in some other manner, the essential point being that the blowing-out may be effected as early as during cracking or at least immediately after cracking has been effected, wherein the expanding arbor 14 should still remain in its position of engagement in the large eye 48 of the connecting rod 2.

In principle, however, external nozzles might also be used to effect the blowing-out operation.

A further characteristic feature of the invention is that the zero position, i.e. the line 76 indicated by dashes and dots in Fig. 2, cuts the centre plane of the connecting rod 2 and the effective plane of the screwing unit 24. Furthermore, said zero position 76 also defines the mid-height region of the expanding arbor 14, thereby enabling optimum utilisation of the latter. The previously described nozzles also open out in the region of the zero position, so that an adjustment of the screwing unit 24, the expanding arbor 14 and the nozzles is

not necessary. Given a change in the connecting rod geometry, it is merely necessary to vary the support height of the connecting rod by changing the cassette 6 and the position and dimension of the guide pin 54, wherein this may be effected by means of prefabricated conversion parts so that the setting-up times are minimised. In other words, this means that the centre plane of the workpiece to be cracked always passes through the zero position 76 indicated by dashes and dots, the position of which is optimally adapted to the expanding arbor 14 and the effective planes of the screwing unit 24 and the nozzles.

For fixing, cup springs are used, which are coordinated with the restoring springs. It is however possible to use controllable cylinders as an alternative to said springs.

In a preferred embodiment, the expanding cylinder 38 is activated by a controller 80 in such a way that both the engagement motion of the expanding wedge 36 and the return motion of the expanding wedge 36 may be effected as a function of processing parameters. Said controller 80 makes it possible to hold the expanding arbor 14 during the screwing operation in contact with the peripheral walls of the large eye 48 of the bearing portion so that also during the initially described assembly/setting operation the connecting rod 2 is precisely guided and no damage as a result of offset of the connecting-rod parts may occur. In said case, as control parameters for the expanding wedge motion it might be possible to use e.g. the torque applied by the screwing unit 24, the angle of rotation of the clamping screw or the like. The function of said controller 80 is described in greater detail below.

As already mentioned initially, the method according to the invention and the machining unit according to the invention are by no means restricted to the connecting rod application, rather they are usable also for other workpieces, e.g. for crankcases.

A problem which often occurs with such workpieces is that simultaneous or consecutive fracture separation of a plurality of bearing points has to be effected. This entails careful support of the bearing cap so that a uniform fracture and a precise assembly/setting operation may be achieved.

Fig. 4 shows a diagrammatic view of a crankcase having a bearing portion 84, which in the region of a bearing eye 86 is to be separated by fracture into a bearing base 88 and a bearing cap 90. For fracture separation, once again an expanding arbor 14 is used.

The problem with said fracture operation is that the fracture never occurs simultaneously in both fracture surface portions 92, 94 disposed laterally of the bearing eye 86 but mostly one of the fracture surface portions 92 or 94 fractures first and only afterwards is the further portion separated. The problem with this is that under unfavourable conditions (material, expansion force etc.) it may happen that the last fracture surface portion to fracture is deformed as a result of tilting of the bearing cap 90, thereby preventing subsequent assembly to the required accuracy.

To prevent this, the bearing cap 90 is supported by means of a support balance 96, which has two support surfaces 98, 100,

which in the normal position (Fig. 1) are disposed at a predetermined distance from the contact surfaces of the bearing cap 90. The support body 102 provided with the support surfaces 98, 100 is loaded with a predetermined force F towards the bearing cap 90, wherein the reference position illustrated in Fig. 4 is fixed by a stop.

During fracture separation the fracture begins first at a fracture surface portion 94, so that the bearing cap 90 runs onto the support surface 98 and is then supported by the force F. Said support prevents the second fracture surface portion 92 from being subjected to excessive bending stress beyond the yield point range, with the result that the previously described deformation may not occur. After initiation of the fracture of the fracture surface portion 92 the bearing cap 90 runs also onto the second support surface 100 so that the bearing cap 90 is supported at both sides, wherein the force F/2 is transmitted via each of the support surfaces 98, 100. Said support is effected on initiation of the fracture so that during the subsequent complete fracture separation an exact guidance of the bearing cap 90 in relation to the bearing base 88 is guaranteed.

In principle, there are several possible ways of supporting the support balance 96. One of these is to support the support balance 96 via a support packing 104 on the expanding arbor 14, which penetrates the support packing 104.

Fig. 5 is a diagrammatic view of a further embodiment of a support balance 96, in which an external support has been selected. Here, the support body 102 is guided in an outer guide frame 106, which is fastened e.g. to the conveying unit

or the support of the workpiece. The support body 102 is loaded with a force F and rests in the illustrated normal position on stop bodies 108, 109 so that the stop surfaces 92, 94 are disposed at the specified distance from the bearing shell 90. Operation is in principle the same as in the embodiment of a support balance illustrated in Fig. 4.

In the previously described embodiments it was assumed that the bearing cap is situated above the bearing base. The bearing cap may however in the previously described embodiments, given an inverted set-up, be disposed in an identical manner also below the bearing base.

There now follows a description of a support of bearing caps, which are situated below the bearing base, in the situation where at least two support balances are required. Said situation may occur when a bearing cap is used, which shares with the bearing base a large connection surface to be cracked, or when a plurality of bearing caps are used.

Figs. 8 and 9 illustrate the situation where seven support balances are used, which are associated in each case with one bearing cap. The mode of operation of the invention is however the same as for bearing cap support devices, which have at least two support balances.

As Fig. 8 reveals, a slider 152 is guided so as to be capable of sliding in a housing 158. The slider 152 is movable in the housing 158 in the longitudinal direction of the slider 152 by means of a linear drive 153, which is designed e.g. as a hydraulic drive or a ball-and-screw spindle drive. The slider 152 has an oblique face 156, which is provided by a notch at

an acute angle to the longitudinal direction of the slider 152. The oblique face 157 of a support balance 151 is in contact with said oblique face 156.
As is evident from Fig. 9, the support balance 151 comprises a yoke 154, on which the oblique face 157 is formed and which connects two pins 151a, 151b to one another. The pins may alternatively be bolts or other devices, the longitudinal dimension of which is greater than their transverse dimension, and extend substantially orthogonally to the longitudinal axis of the slider 152. In order to protect a movement of the pins in their longitudinal direction, a recess of the size of the yoke is formed in the housing 158, in the manner shown in Fig. 9. The yoke engages into said recess on a lifting movement of the pins.

Further support balances 251, 351, 451, 551, 651, 751 are disposed in an identical manner to the support balance 151 on the periphery of the slider 152.

In the retracted position of the slider 152 the pins project by a minimal dimension from the housing. When a linear movement of the slider 152 then occurs as a result of actuation of the linear drive 153, a force is exerted by the oblique face 156 of the slider 152 orthogonally to the longitudinal axis of the slider on the oblique face 157 of the pressure balance 151. The pins 151a, 251a of the support balances therefore move further out of the bearing cap support device, in the manner shown in Fig. 8. In said state the pins are however not yet in contact with the bearing caps 191, 192. It is only on commencement of the fracture operation that initially only the one portions of the bearing caps 191, 192, which have been subjected to cracking, and then later also the

other portions of the bearing caps 191, 192, which have subsequently been separated by cracking, are supported against the support balances.
In said manner it is possible in one work cycle purposefully to crack off either a plurality of bearing caps or large bearing caps. Besides the low hardware outlay, such an apparatus has the added advantage of enabling fracture separation to be effected to a high degree of accuracy.

The embodiment described with reference to Figs. 8 and 9 is however usable not just for bearing caps, which are situated below the bearing base. By arranging the bearing cap support device in such a way that the free end faces of the pins 151a, 251a in Fig. 8 are directed downwards, the situation is also covered where the bearing caps are situated above the bearing base. In said case, however, care has to be taken to ensure that the respective yoke does not fall out of the corresponding recess in the housing 158. This may be ensured by means of corresponding projections on the support balances, preferably on the pins.

For improved understanding, there now follows a brief description of the operation of the machining unit according to the invention.

At the start of the machining cycle a connecting rod 2 is placed onto the outer cassette 6 illustrated in Fig. 1. By means of the conveying unit 4 (e.g. rotary table) the connecting rod 2 is aligned in its machining position in relation to the laser unit 10. By means of the laser unit 10 the two notches defining the fracture plane are worked into the peripheral wall of the bearing eye 86 of the connecting

rod 2. It is, in principle, also conceivable for the notches to be formed in a conventional manner, e.g. by broaching.

On a further rotation of the rotary table the connecting rod 2 is brought into the position relative to the cracking unit 12 illustrated in Fig. 1. The cylinder 18 is then actuated so that the horizontal stop 22 is moved into its stop position. At the same time, by activating the actuating cylinder 30 the entire cracking unit 12 is lowered so that the expanding arbor 14 engages into the large bearing eye 86.

By activating the controller 80 the expanding cylinder 38 is extended so that the expanding wedge 36 is moved downwards and the movable expanding jaw 34 is moved to the right in the view according to Fig. 2. At the same time the nozzles are activated so that compressed air is blown into the fracture plane region during the cracking operation. This means that the fracture separation and blowing-out operations are effected simultaneously or at least one immediately after the other.

In the illustrated embodiment, the rod 52 having the bearing base is practically separated so that said components having the small eye 50 yield to the right in the view according to Fig. 2. Said yielding motion is enabled by the spring-loaded guidance of the guide pin 54. The horizontal stop 22 travels downwards and clears the space for the subsequent screwing operation.

After fracture separation of the connecting rod 2 and in the engaged state of the expanding arbor 14 the screwing unit 24 is brought along the zero position line 76 into its working

position and the fixing screws are screwed in. In said case, the controller 80 may as a function of the screwing angle or the torque of the screwing station 24 control the expanding arbor 14 in such a way that the connecting-rod parts are guided during the assembly/setting operation and precise positioning is possible.

In a simpler variant of the invention the expanding arbor 14 may be retracted prior to insertion of the fixing screws, with the result that said guidance has to be effected by other external structural elements. The essential point is, however, that the cracking and screw-connection operations are effected at a single station without changing the position of the connecting rod 2.

Actuation of the expanding arbor 14 during the screwing operation need not necessarily be effected via the expanding wedge 36, rather other suitable structural elements for radially moving the movable expanding jaw may be used. Actuation may be effected e.g. via a cylinder, which acts on the movable expanding jaw.

After the assembly/setting operation through tightening of the screws, which may be effected in a torque-, rotation-angle- or yield-point-controlled manner, the fixing screws are loosened again and any remaining fragments are blown out by activating the nozzles. The clamping screws are then tightened according to the manufacturer's specification and the connecting rod is conveyed to the next production step, e.g. micro-machining or the fitting of bushes.

By virtue of the development according to the invention of the machining unit, the precision of the assembly/setting operation may be considerably improved because no conveying step is provided between the cracking and screwing operations. An added advantage of the unit according to the invention is that all of the operations required for fracture separation (laser notching, fracture separation, blowing-out, assembly/setting) may be carried out in a very confined space by a single compact unit, which is moreover very rapidly adaptable to different component geometries simply by exchanging conversion parts, with the result that said unit should also be suitable for small batches.

In the previously described embodiments, the screwing unit 24 is fastened in such a way to the frame of the machining unit 1 that its effective line coincides with the zero position 76 (centre plane) of the connecting rod 2.

Fig. 6 is a diagrammatic view of an embodiment, in which the screwing unit 24 and the counter-holding device 16 having the horizontal stop 22 are guided along an additional vertical axis 110. This means that in said embodiment the screwing unit 24 is adjustable in the direction of the height of the workpiece 2, with the result that the previously described zero point fixing no longer applies. Said development allows the counter-holding device 16 and the screwing unit 24 to be easily adapted in height to the workpiece geometry 2, with the result that the set-up times may be further reduced.

In the initially described embodiment hydraulic or pneumatic cylinders were used for adjustment. It is naturally also possible to use NC axes with suitable positioning motors to

effect the vertical and horizontal feed of the cracking unit 12, the screwing unit 24 and the horizontal stop 22.

In a further configuration stage of the device it is provided that the process variables such as e.g. displacement and forces are acquired and evaluated in a way that enables purposeful process management. For example, in an interesting variant of the device the cracking noise is detected and used to terminate the cracking motion.

In the embodiment in Fig. 6 the screwing unit 24, as in the previously described embodiment, is displaceable along a horizontal guide 26 in order to reach its engagement position at the workpiece 2.

The setting-up times for conversion of the machining unit to different workpiece geometries may be further minimised when a setting-up apparatus 112 according to Fig. 7 is used.

By means of said setting-up apparatus 112 the conversion parts of a cassette 6 may be pre-adjusted outside of the machining unit 1, so that the actual conversion and hence the down time of the machining unit 1 is reduced to a minimum.

The setting-up apparatus 112 illustrated in Fig. 7 has a base plate 114, on which a guide 116 is fastened. The latter carries a fastening limb 118 for an expanding cone 120, the geometry of which corresponds to that of the expanding arbor 14 of the machining unit 1. The fastening limb 118 is displaceable in the vertical direction along the guide 116.

There is further fastened to the guide 116 a counter-holding device 122, which can be brought into contact with the end face of the connecting rod 2 or of another workpiece. The cassette 6 with the conversion parts is fastened on a pedestal 124.

A holder for centring pins 124 is mounted on a fastening limb 122 guided on the guide 115. The limb 122 moreover has an (e.g. engraved) reference line, which simulates the laser beam. Thus, by means of a master connecting rod with marking of the setpoint notch position the correct setting for the connecting-rod centring may be checked and optionally corrected.

The rear, rod-side centring of the small bearing eye is effected by the fixing pin 54. The latter is fastened on a sliding piece 126, which is guided displaceably in the basic body 128, and preloaded by a spring into a normal position. For manual actuation of the sliding piece 126 an actuating limb 130 is provided, which projects downwards from the basic body 128. Adaptation of the conversion cassettes 6 to different connecting-rod geometries is effected substantially by exchanging the guide pin 54 with the sliding piece 126 and the centring pins 124 with the associated receiving body. A variation of the zero point position 76 might optionally additionally be effected by distance parts (not shown), which are laid under the cassette 6.

The correct adjustment of the cassette is checked by moving the expanding cone 120, in the adjusted state of the cassette 6, downwards in the view according to Fig. 7, wherein said

expanding cone should engage in a collision-free manner into the large eye.

Disclosed are a method of forming a divided bearing of a component as well as a machining unit for effecting said method, in which the fracture separation, blow-out and screw-connection of a bearing cap to a bearing base are effected without changing the position of the connecting rod.

Claims

1. Method for forming a divided bearing for a component (2) which is separated into a bearing cap (90) and a component-side bearing base (88) by a fracture separation process and is assembled after loose fragments have been blown out, fracture separation being effected by an expanding arbor (14) and screwing being carried out in such a way that a predetermined assembly state is achieved in the fracture plane, characterised in that fracture separation, blow-out and screwing take place at a common station and without substantial changes in the position of the component (2), the expanding arbor (14) also being used for fixing in position during the blowing out and assembly process.

2. Method according to claim 1, characterised in that the blow-out is also carried out during fracture separation or immediately thereafter.

3. Method according to either of the preceding claims, characterised in that an expanding force counteracting the assembly force may be applied to the bearing cap (90) and the bearing base (88) during assembly.

4. Machining unit, in particular for carrying out the method according to any of the preceding claims, comprising an expanding arbor (14) which may be introduced into a bearing bore (48) of a component (2) for fracture separation and comprising a gripping support (6) for the component (2), with a blowing device (60, 62; 72, 74) and a screwing unit (24), wherein fracture separation may be carried out by the expanding arbor (14), characterised in that the blowing device

and the screwing unit may be brought into engagement with the component (2) in the fracture separation station and the expanding arbor may also be used for fixing in position during a blowing out and assembly process.

5. Machining unit according to claim 4, characterised in that the blowing device has at least one nozzle (64, 66; 72, 74) which opens in the expanding arbor (14) in the region of the parting plane of the component (2).

6. Machining unit according to claim 5, characterised in that the nozzle (64, 66; 72, 74) is formed in an expanding wedge (36) of the expanding arbor (14).

7. Machining unit according to any of claims 4 to 6, characterised in that the centre plane of the component contains a fixed reference plane (76) of the expanding arbor (14), the screwing unit (24) of the blowing device (60, 62; 64, 66; 72, 74) and a counter-holding device (support balance).

8. Machining unit according to any of claims 4 to 6, characterised in that the screwing unit (24) and optionally a counter-holding device is capable of travelling on a guide arranged parallel to the axis of the bearing bore.

9. Machining unit according to any of claims 4 to 8, characterised by a controller (80) by means of which the expanding arbor (14) may be kept in contact with the bearing base (88) and the bearing cap (90) during the fracture separation and/or screwing process.

10. Machining unit according to claim 9, characterised in that the controller (80) may be activated as a function of the relative position of the bearing parts (88, 90) or of the breakaway torque or screwing angle of the screwing unit (24).

11. Machining unit according to claim 9 or 10, characterised in that the controller (80) has a cylinder or an electromagnetic drive by means of which the expanding arbor (14) may be brought into contact with the bearing parts (88, 90).

12. Machining unit according to any of claims 4 to 11, in which the bearing cap (90) and/or the workpiece part containing the bearing board is supported during fracture separation, characterised by a support balance (96) with two support surfaces (98, 100) by means of which the bearing cap (90) or the workpiece part may be loaded with a predetermined force (F) and which are arranged at a predetermined distance from the bearing cap (90) at the beginning of the fracture separation process, the second workpiece half similarly also being supported by a support balance or a support bridge in such a way that the proportion of fracture by bending during the second fracture is minimised as a result of a predetermined distance from the workpiece.

13. Machining unit according to claim 12, characterised in that the support balances are each connected - rigidly or resiliently - on either side to the expanding arbor halves.

14. Machining unit according to any of claims 4 to 13, characterised by the combination with a preceding laser unit for introducing notches.

15. Machining unit according to any of claims 4 to 14, characterised in that the workpiece (2) is arranged on a cassette (6) which may preferably be adapted to different workpiece geometries.

16. Machining unit according to claim 12 with at least one further support balance (151), wherein the support balances (151, 251) may be loaded with the predetermined force by a slider (152).

17. Machining unit according to claim 16, wherein at least two bearing caps are supported by the support balances (151, 251).

18. Machining unit according to claim 16 or 17, wherein each support balance (151) comprises at least one pin (151a) of which the longitudinal axis extends orthogonally to the direction of movement of the slider (152).

19. Machining unit according to claim 18, wherein each support balance (151) comprises two pins (151a, 151b), which are connected to one another via a yoke (154).

20. Machining unit according to claim 18 or 19, wherein force is transmitted between the slider (152) and the support balance (151) via oblique faces (156, 157) of the slider and the support balance (151) which are in contact with one another, wherein the oblique face of the slider (152) extends at an acute angle to the movement axis of the slider (152).

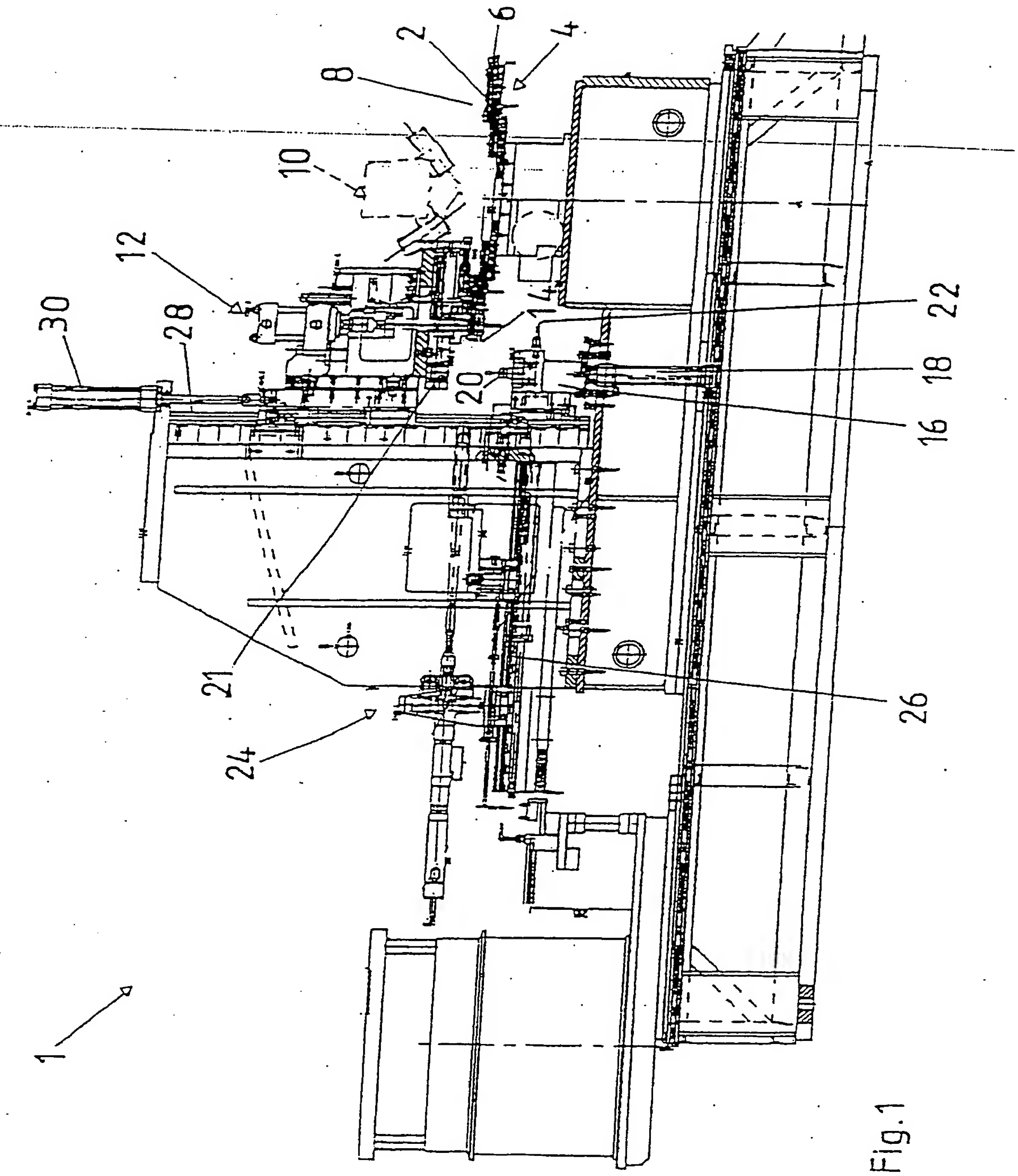


Fig.1

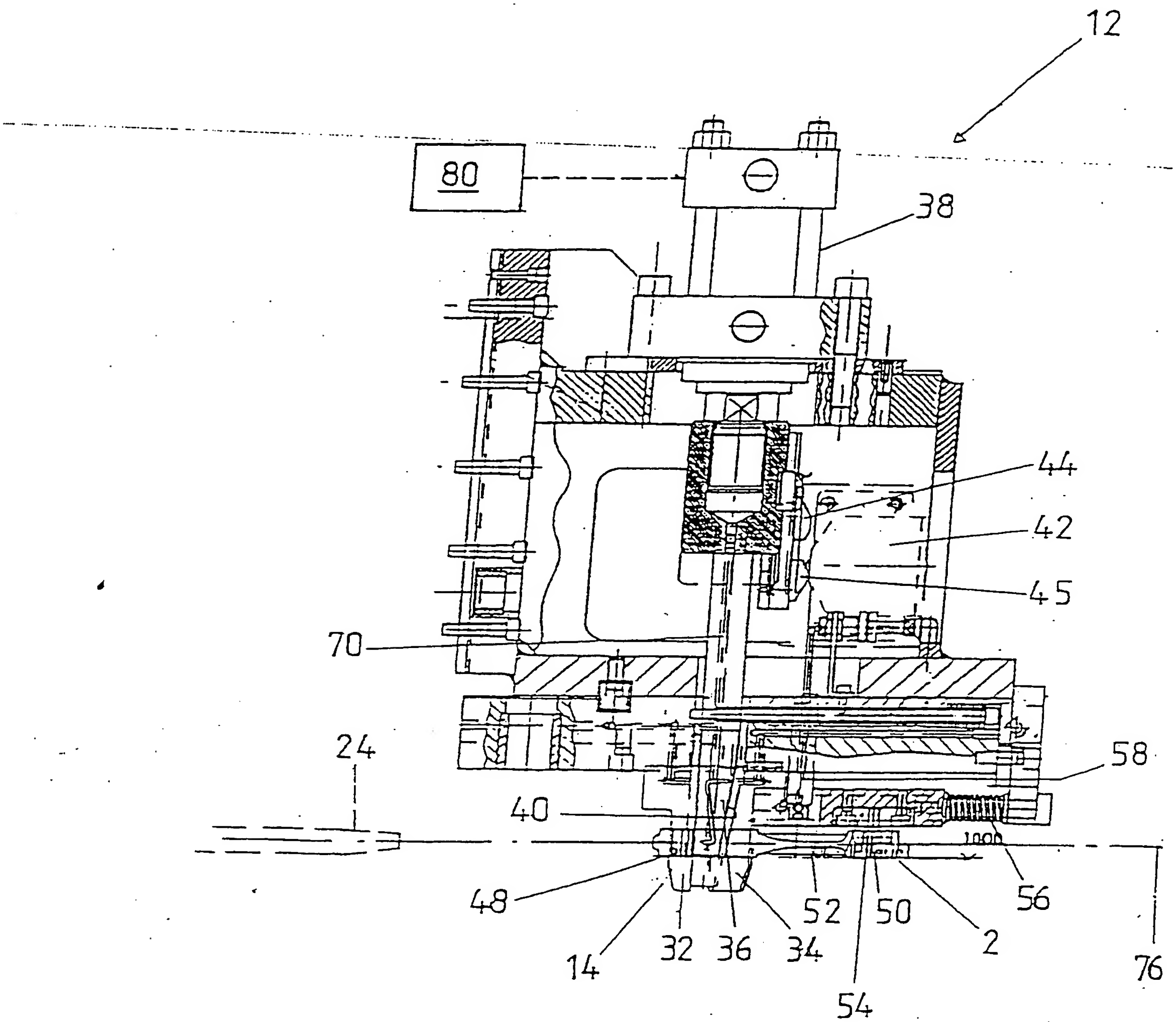


Fig. 2

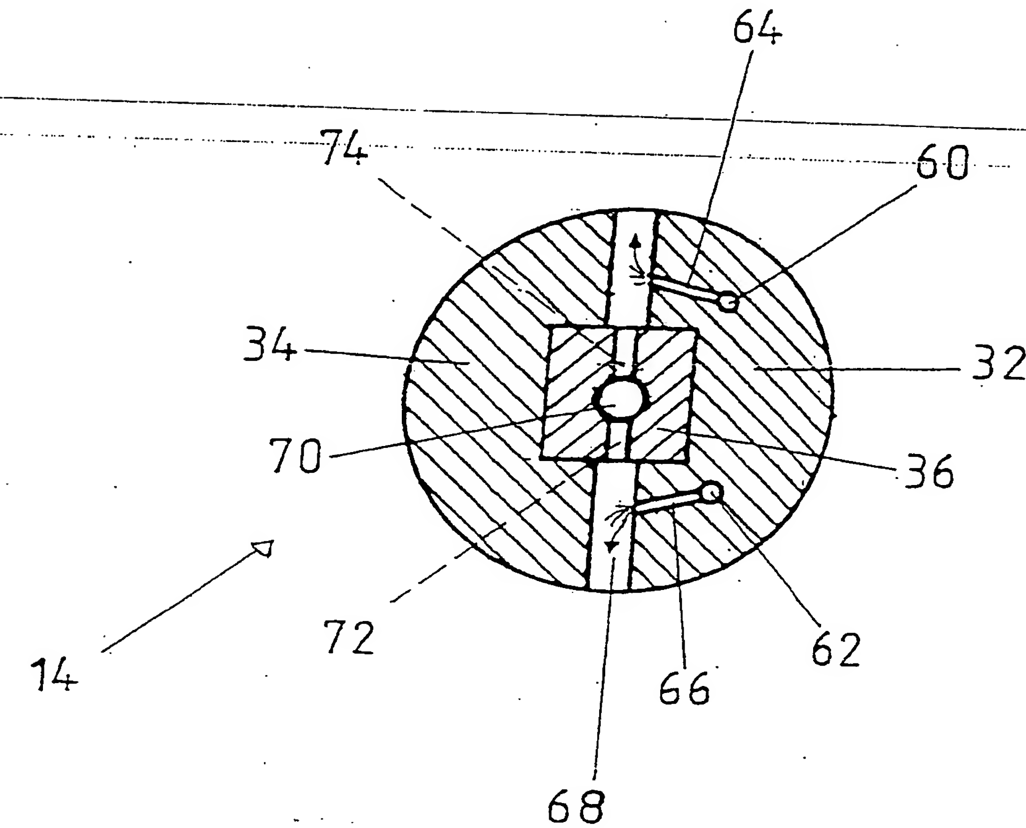


Fig. 3

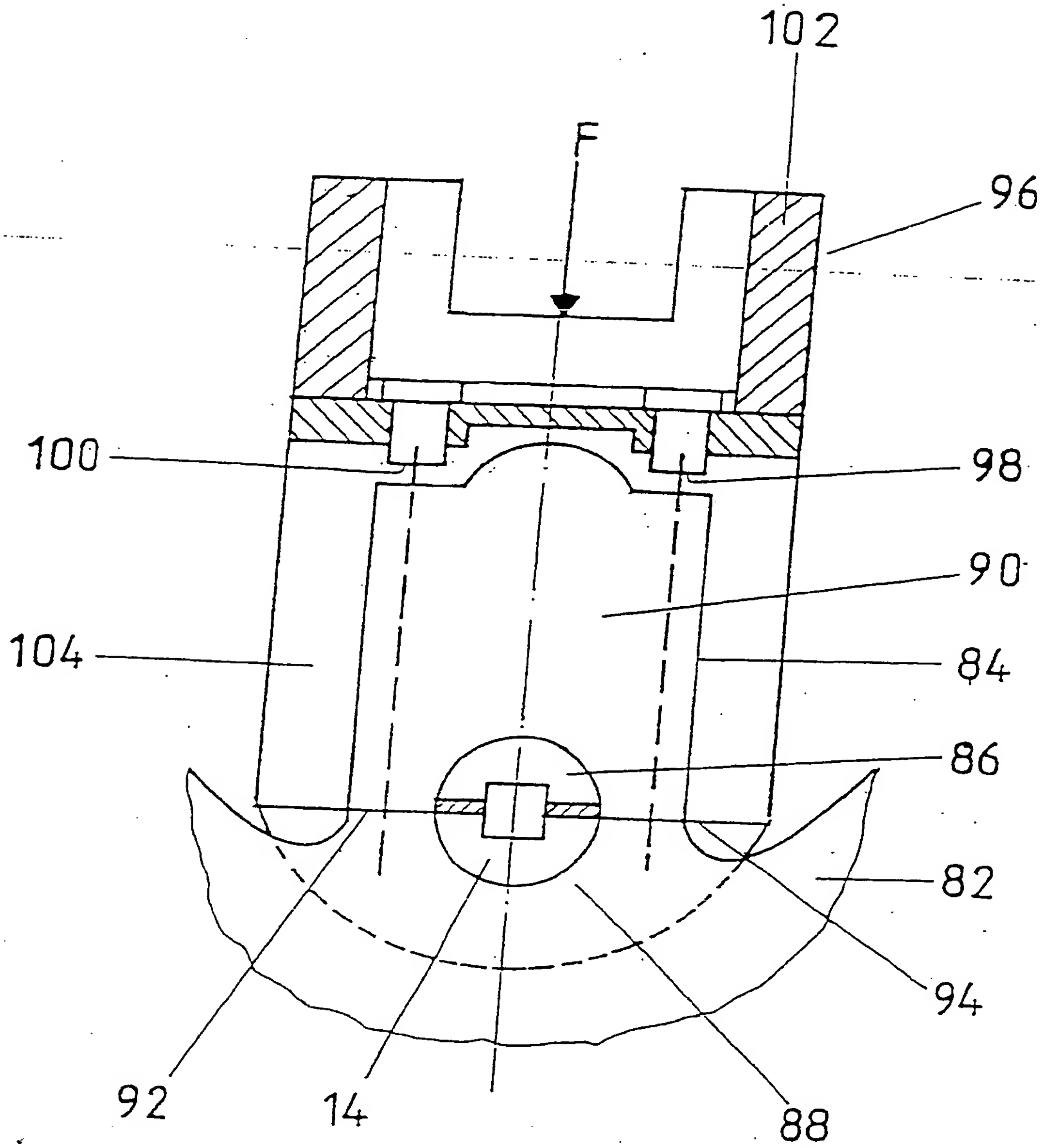


Fig. 4

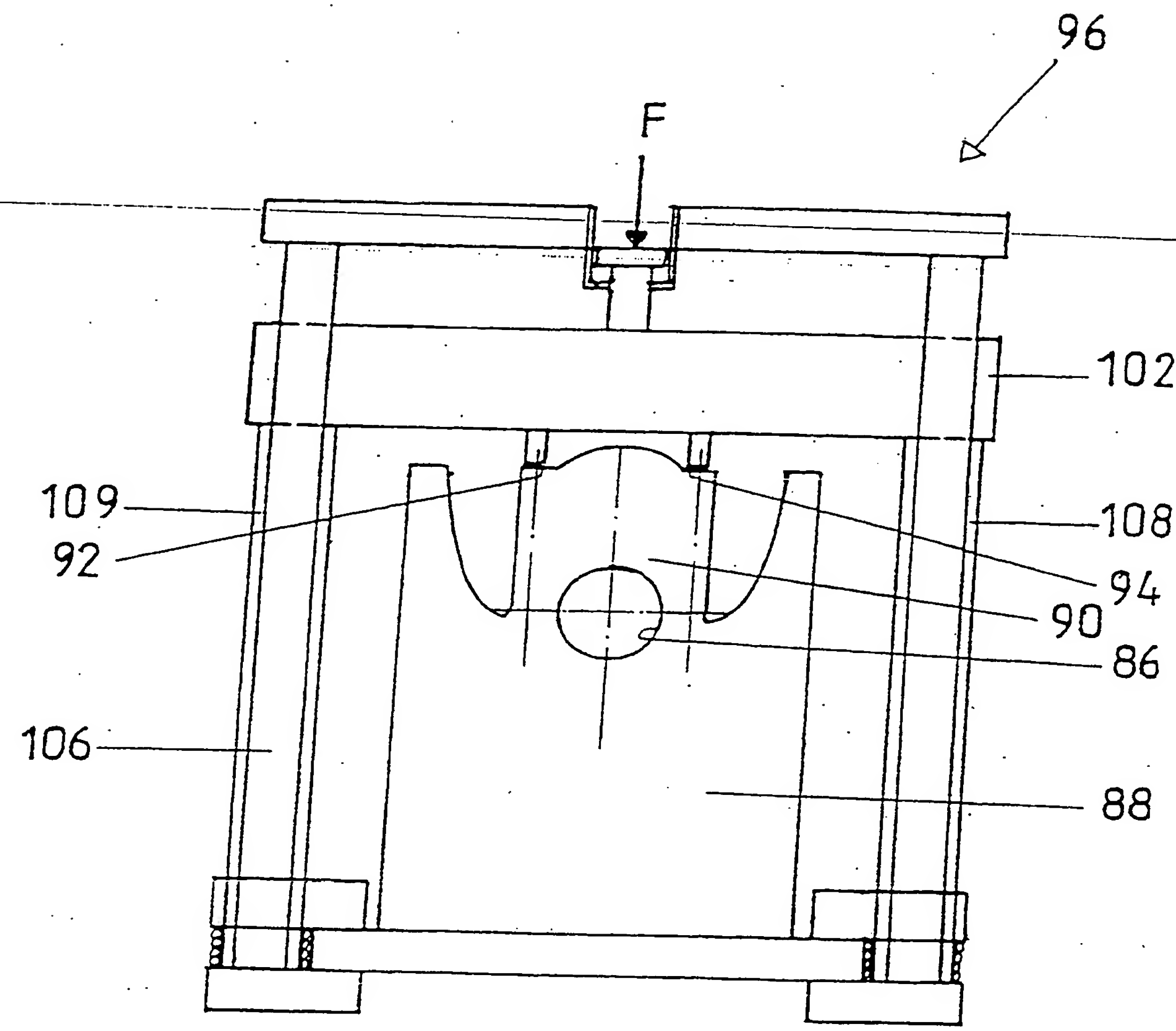


Fig. 5

Fig. 6

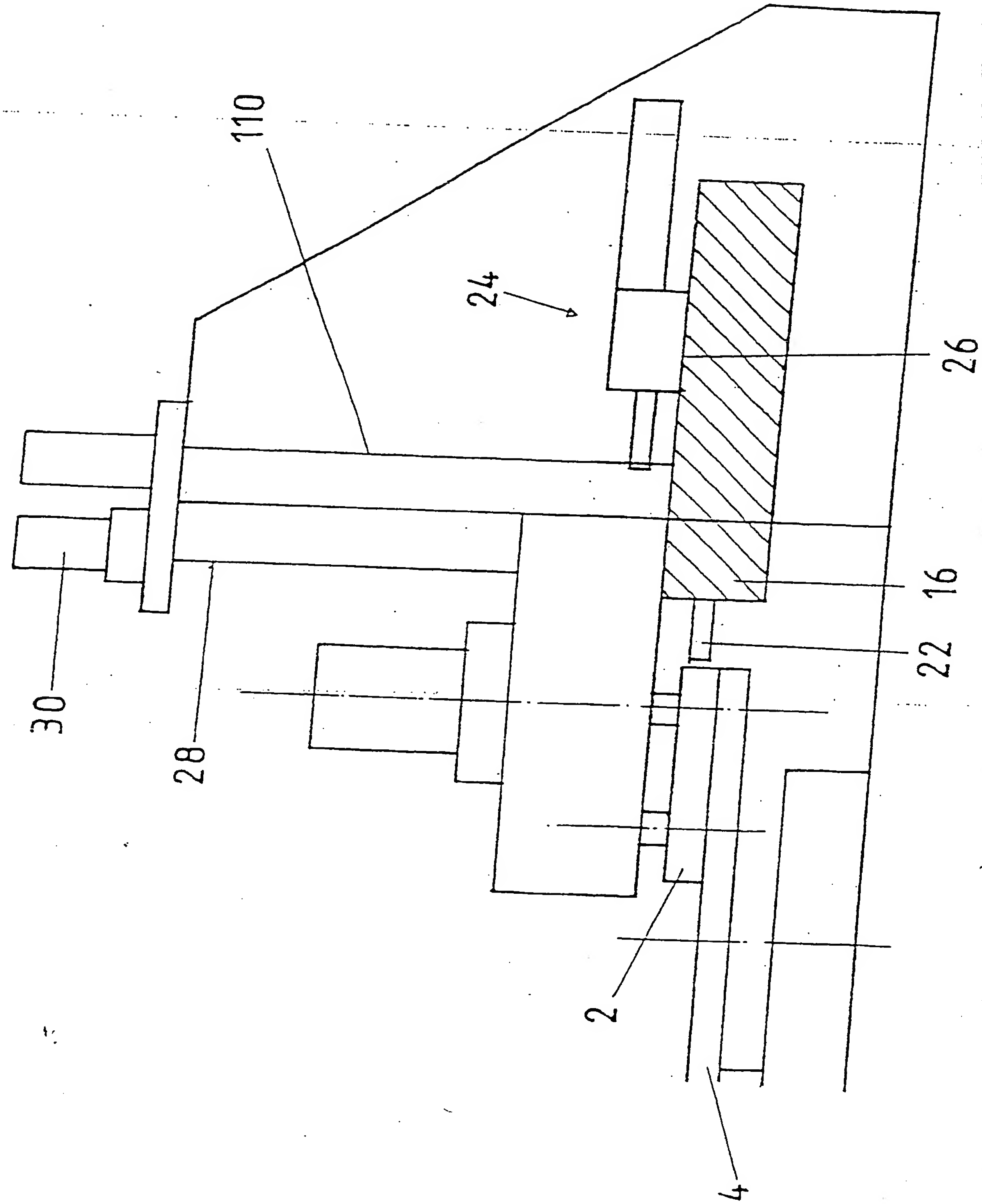
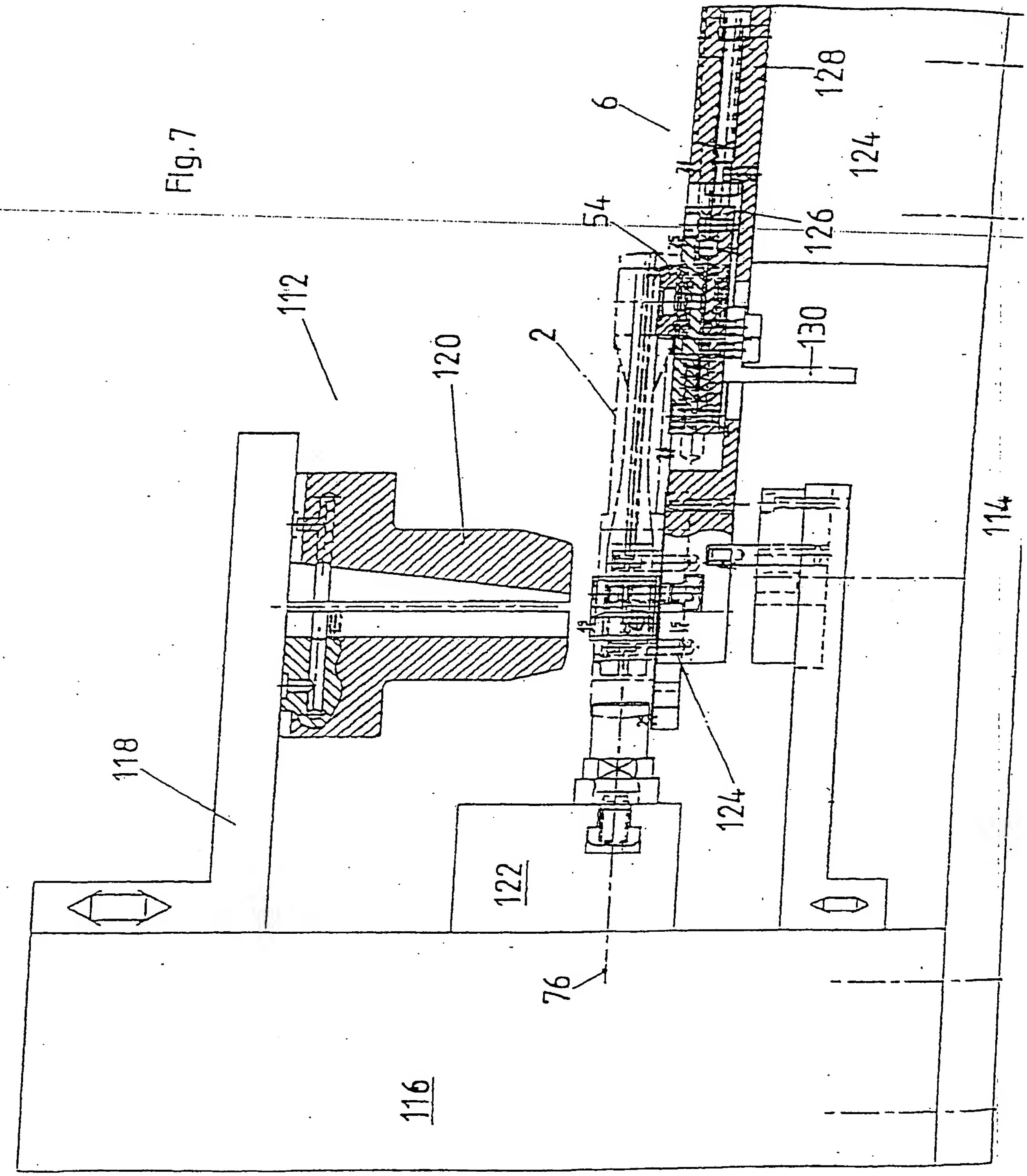


Fig. 7



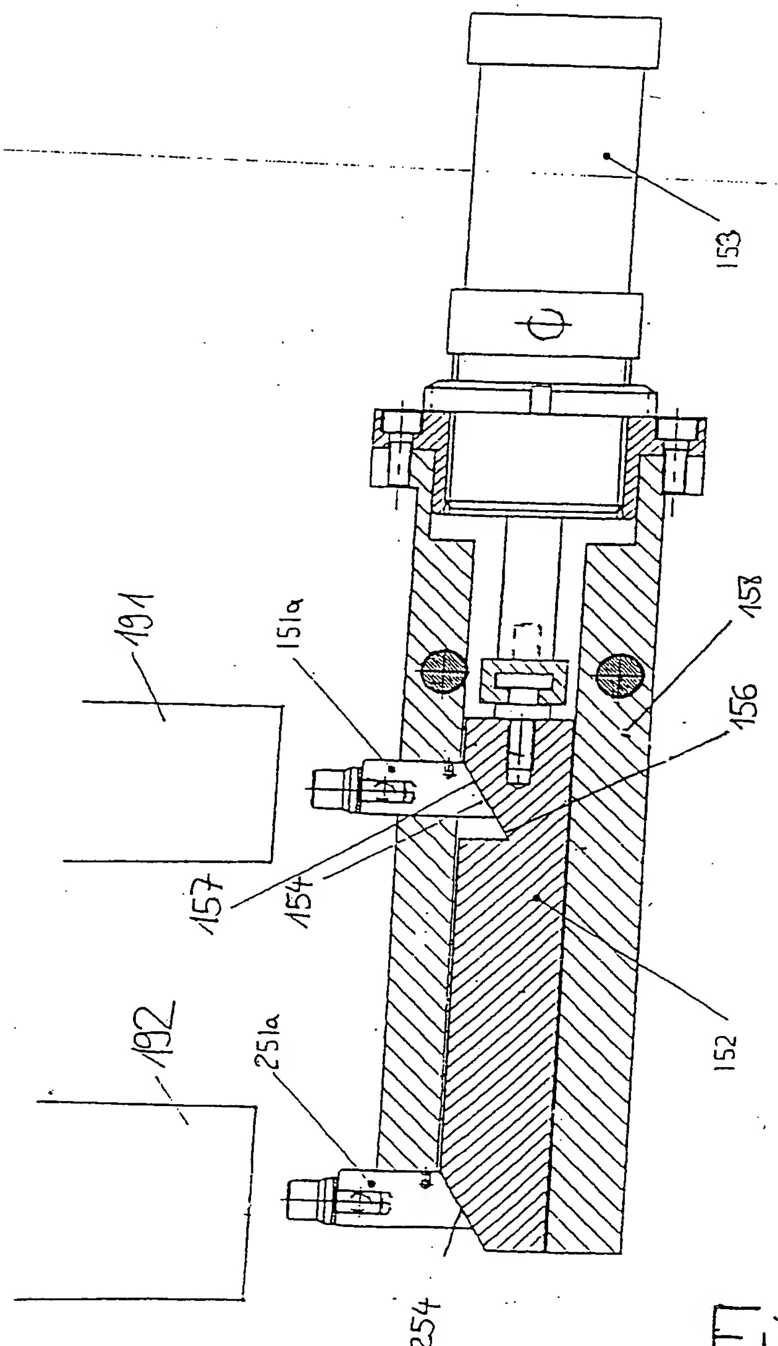


Fig. 8

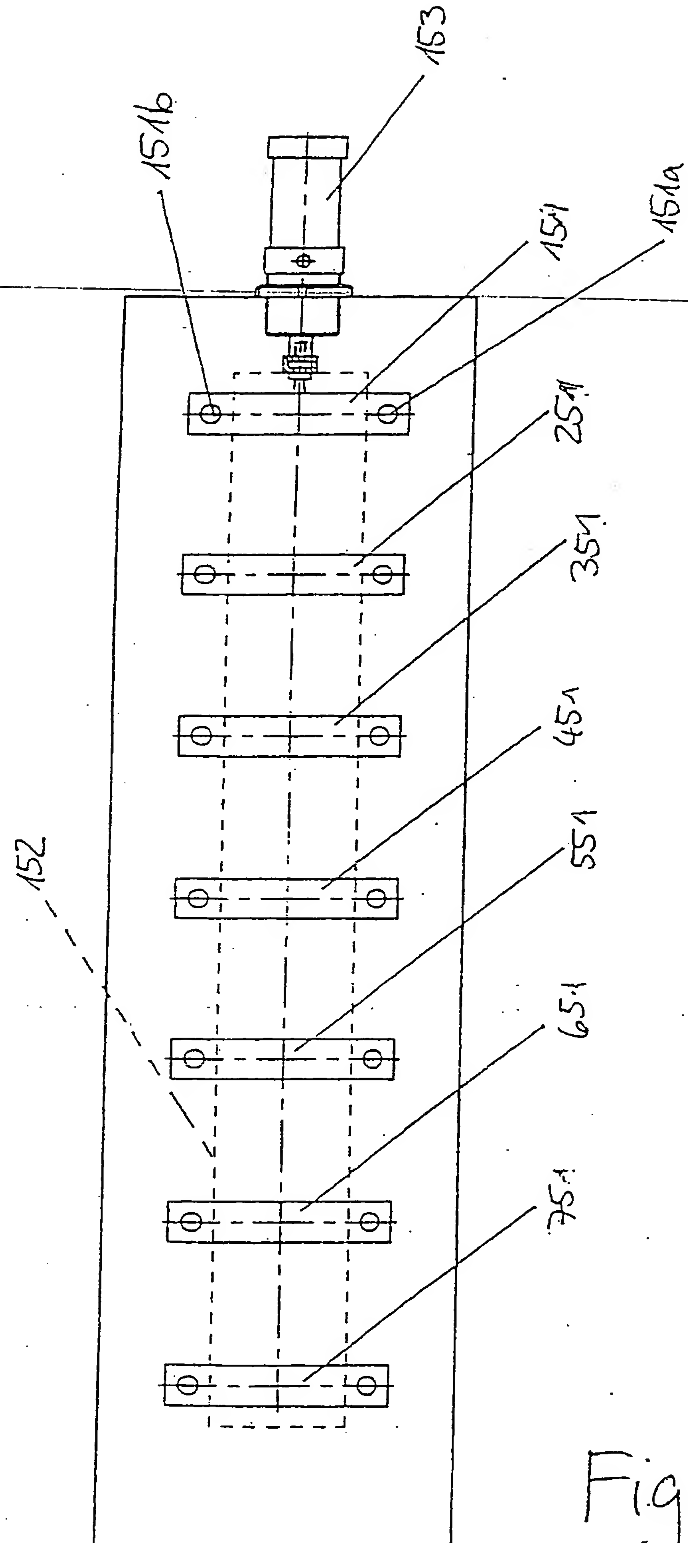


Fig. 9